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REFLECTIONS ABOUT THE CRAFTSMANSHIP OF MAKING IRON AND STEEL WEAPONS IN GEORGIA

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ABSTRACT

Metallurgy has always played an important role in the almost 4000-year history of Georgia's statehood. Its specificity, development, ups and downs and new reincarnations in other times and places, over and over again, is the main plot of this article. The metallurgical centers of South Georgia (the Lower Caucasus Range) are considered the birthplace of iron metallurgy in the world and throughout the ancient era played a leading role in the markets of the then world. However, during the Middle Ages, Georgian metallurgy was forced to hide in the Northern Mountains to keep away from aggressive invaders, and suffered from a limited ore base and isolation. The article attempts to analyze and clarify iron deposits in Georgia, which may have been used by ancient metal masters. In addition, those small elements were established that were added to iron to produce high-quality steel, and later Damascus steel in Georgia.

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Introduction.

Once, while sorting out old things at home, the one of the authors of the article discovered a dagger (Fig. 1) that belonged to his great-grandfather, Ivane Kuparadze. The damask steel blade of the 19th century with a handle made of buffalo bone was shown with a cold sheen. The unusual pattern on the surface of the blade predetermined our modest study, affecting the deposits and ore occurrences of metals, the metallurgical processes for their production and the technique of manufacturing steel products in the Caucasus.

The dagger is a symbol of the Caucasus, its history, traditions, folklore, an obligatory attribute of a man's costume, a symbol of courage and readiness to defend one's honor, the honor of the family, people and country. The dagger, as a talisman, was inherited, and its safety was the honorable duty of every family.

The Georgian state throughout its existence has been an arena of invasion and warriors from all imperial states and various neighboring volumes. After the repeated invasions of the Persians, Tatars and Mongols on Georgia, in the Middle Ages in I522 AD the Persians take Tiflis, which is liberated two years later by the King of Kartli (East Part of Georgia) - David X. During this period, the capital of Georgia was the city of Tiflis and some of its quarters were rebuilt, but already in the 17th century, Tiflis again became the scene of terrible invasions for the country. This time, Tiflis was more the object of conflict between the two empires than the target of the invaders: the Ottoman Turks and the Safavid Persians were fighting for control of the city. It ended in 1795 with the burning of the ancient capital of

the Caucasus by Agha Mohammad Ghan. So, feeling that Georgia could no longer resist its enemies alone, in 1783 King Irakli (Erekle), out of hopelessness, decided to turn to Russia for help. Since the history of Georgian statehood is the history of wars, then, first of all, at each historical stage, either traditional weapons are improved, or new types of weapons appear. The same sad fate befell the Caucasian dagger, which gradually turned from a vital item into a collectible.

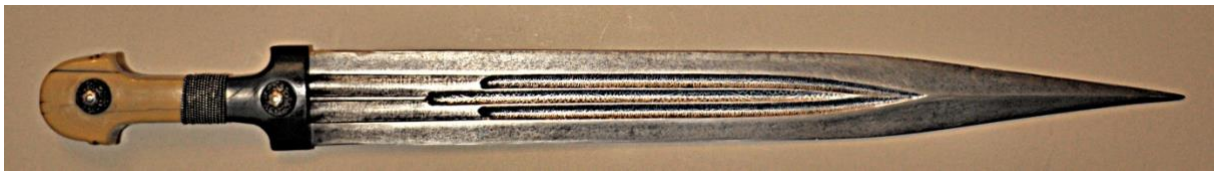

Fig. 1. Typical Georgian dagger. XIX century;
Property of the author, owned by the great-grandfather of the D.Kuparadze.

The artisans who made edged weapons and their several generations lived together in the spacious houses of Tbilisi (Fig. 2 a, b). They got used to the type of housing for two generations with great pleasure. Quite often, in one house, this happened for three generations, which did not bother the younger generation at all, and by this circumstance, the young learned from the elderly to respect the elders and traditions and achievements for national identity. However, temporary progress has led to the loss of most of the centuries-old traditions and called into question the process of succession of generations. World economic, political, cultural integration, unification and the irreversible process of urbanization, of course, could not but affect the mentality, life and way of life of traditional Caucasian families.

Fortunately, all is not lost yet. In traditional families, you can still find interesting and educational things. In addition, in recent years, young Georgian lovers of old steelmaking and the production of edged weapons have become intensively engaged in the restoration of downtrodden traditions and have reached great heights.

Fig. 2.a. Panorama of the old city - Tbilisi, in which craftsmen's workshops were located on the first floors.
Photo by D.Kuparadze.

Fig.2.b. Typical dressing of a Tiflis (Tbilisi) citizen of the 19th - early 20th century.

General issues of metal production in Georgia.

In order to appreciate the progressive development, improvements in the manufacture of Georgian edged weapons, we will have to at least briefly touch on the history of the development of Georgian iron metal production over the past 3000 years. How was this profession started and to what extent? After all, even Julius Caesar, in "Notes on the Gallic War" stated that "The beginning of the production of iron in any living settlement means the end of its existence as a savage, and the beginning of progressive being and education in this people."

The history of the state of Georgia originates in the II millennium BC during the period of coexistence of Colchis and Central Transcaucasian cultures. According to a number of scientists [G.Inanishvili, 2007; D. Kuparadze, D. Pataridze, 2008], “it can be said with certainty that the distant, legendary ancestors of the Georgians were highly cultured and interesting people”. The latter, perhaps, is also associated with the highest art of metallurgy - they were great masters of metal - first of all copper and gold, then bronze, and after this silver and iron. The ancient Georgian tribe of Tubals (Tuvals) is even defined in the Bible as the inventor of metallurgy and blacksmithing. The metal products of the ancient Georgians spread throughout Asia Minor - Mesopotamia, Syria, the states of Asia Minor. The masters of making damask blades - the Assyrians, quite possibly, learned their art in many ways from the ancestors of the Georgians.

The ancient tribes living on the territory of ancient Georgia - Khalibs, also already then at the beginning of the 1st millennium BC knew the technology for producing high-quality iron, and later steel. The ancient Greeks believed that the Khalibs discovered iron metallurgy and passed it on to the Hittites (Edmond Truffaut, 2014). The Khalibs lived on the territory of ancient Colchis, and the extreme points of their residence were from the south of Trabzon (Trapezond) to the north of Phasis River (now it is called Rioni River). They already then used an iron-manganese-carbon alloy, and after all, the discovery of manganese took place only in 1770 AD. Gradually, they began to produce (in the 1st century BC) iron products, which were improved as steel (Edmond Truffaut, 2014). From the beginning of their existence, they, as tribes, occupied a vast territory in Colchis (Fig. 3), which they appropriated for themselves for metallurgy, as well as for food crops and flax production.

After 401 BC, living with fishing and the iron they produced, the Khalibs scattered in Pontids along the southeastern coast of the Black Sea. They were stopped by the delta of Thermodon towards Unya, where they were last discovered around 1400 AD. (Edmond Truffaut, 2014).

It is confirmed that the production of iron on the territory of Georgia began at the end of the second millennium BC. For example, the production and forging of iron in Racha region (North Georgia) has been known since time immemorial.

Fig.3. Map of ancient Georgia showing the ancient regions of Colchis and Iberia (two parts of ancient Georgia) as well as the local (Proto-Georgian) tribes inhabiting them. The map was compiled by M. Shekiladze (2001) and supplemented by D. Kuparadze. (D. Kuparadze, D.Pataridze, 2008).

The possibilities to extracting and producing high-quality metal by the Kartvelian (Georgian) tribes is very clearly evidenced by mine workings dating back to the 5th-4th millennium BC, which were found and excavated by both Georgian and German scientists in South Georgia (Fig. 4). It was proved that already in that time the ancient masters has clearly separated the functions of metal production. The first workers destroyed mines along various tectonic faults (which were easier to work and which contained the main mass of gold) with the help of fire (hot stones were cooled by water, as a result of which the rock was cracked) and stone sledgehammers and brought the mass of rock up; the second group crushed this breed; the third - washed and melted the crushed rock and thereby extracting pure gold. Along with this, the ancient Kartvelian (proto-Georgian) tribes produced bronze, silver and iron, and later steel (Kuparadze, Pataridze, 2008).

F*ig.4. Ancient mining in rhyolite rocks on the territory of the Bolnisi region near the village of Sakdrisi. In V-IV thousand years BC by mine method was massively mined mainly for gold and possibly for copper. (Th. Stöllner, Ir. Gambashidze. 2014).*
Photo by D. Kuparadze.

The ancient centers of metal production, mainly for iron production, were located in the South-Western, South-Eastern and Northern parts of Georgia. The first of them occupied the basin of the Chorokhi River, within the boundaries of ancient Shavsheti, Tao-Klarjeti (the territory of Georgia until 1921), Javakheti, as well as the territory of present-day Guria and Adjara (see Fig. 3). The second covered the southern regions of ancient Iberia (Eastern Georgia), where, from a metallurgical point of view, the territory of the present-day Bolnisi (South-Eastern Georgia) and Alaverdi (the territory of Georgia before 1931) regions have particular interest. And the Northern centers - represented the mountainous regions of the Southern slopes of the Greater Caucasus Ridge within the borders of Abkhazia, Svaneti, Mengrelia, Upper Imereti and mainly Racha districts.

The metallurgy of the South had a complex nature and included both the smelting of copper and iron, as well as gold and silver. The diversity of ancient Georgian metallurgy is evidenced by Greese-Roman scientists, who were surprised by the skill of making metals by Mossiniks, Khalibs and Tubals (ProtoGeorgian tribes). The few tribes of the Khalibs, subject to the Mossiniqs, lived mainly by mining and processing iron. Mossiniks apparently had fairly close trade relations with the Greek cities. They were famous for the technique of making copper, bronze and brass. They, in the manufacture of bronze products, mixed copper not with lead, but with some kind of “local earth” (arsenic), which they melted together with copper and obtained an alloy that had a special luster and stood out in whiteness. Tubals (Tuvals) - were great masters of metal - first copper, then bronze, and then iron. At first, the Tubals lived not only in the South Caucasus, but also in Asia Minor, up to its southern part. However, they were ousted from there during the great Aryan migration.

It is quite obvious that the narrow specialization of individual tribes was the result of a firmly established division of social labor. Such specialization in the process of historical time developed in individual tribe’s production traditions, dexterity, technical skills and improved methods of metal production.

The highly developed production of metals, and in particular iron, served not only as a source of livelihood for many ancient Georgian tribes, but also connected ancient Georgia with the outside world. Metallurgy became the basis for intensive trade with the highly developed states of the ancient era. This is a very important historical fact, which clearly indicates the relatively large scale of iron production in Georgia.

It should be emphasized that the metallurgical industry in Georgia was not random and not temporary, but was an organic component of the economy. It constantly showed a tendency to reproduce, while passing through a series of historically determined phases of either decline or a new revival.

The fact that scientists of different periods invariably emphasize the existence of high technology of metallurgical production in Georgia, and some of them pay tribute to the remarkable art of making iron and copper by the ancient Georgian tribes is a convincing proof that the metallurgical industry has never lost its importance in general in whole economy of the country.

Assyrian inscriptions prove that Muski (Colchis settlers) in the 11th century BC were mainly engaged in viticulture and metalworking. The Tabal tribe seems to have been even more advanced in metallurgy. Their silver mines were captured in 837 BC by Salmansar II. Tubal (Tabal) Cain, mentioned in the Bible (Cain means blacksmith in the Semitic language), "was a stone carpenter, a blacksmith of octal steel and iron."

According to the Bible, the mentioned tribes traded their metal products over a vast territory. Pseudo-Aristotle describes the technological process of the Khalibs, adding that "only this iron does not oxidize." The metallurgical knowledge of the Khalibs was so superior to that of others that even contemporaries of that time made legends about them.

The number of iron weapons found in the burials (arrowheads, spears, daggers, etc.) steadily increased in the monuments from the end of the 2nd to the beginning of the 1st millennium BC. It is obvious that the mass production of iron implements began in the 9th century BC, the so-called period of widespread development of iron, and by the middle of this millennium, iron weapons had completely replaced bronze ones.

As a result of research conducted in the early 50s of the last century, scientists came to the conclusion that in the Middle Ages of the 2nd millennium BC, the ancestors of Georgians even used a metal stamping machine. That is, sheet metal processing was carried out on special equipment with a rotating spindle. During the excavations carried out by the famous archaeologist B. Kuftin in 1949 on

the territory of Samachablo, a two-sided tip (with different geometry) of a bronze knife ("stamping") was also found, the strength of which is 3-4 times higher than the strength of gold and silver.

Written sources have preserved noteworthy information about the high level of iron processing among the Georgian tribes of southwestern Georgia, and modern archaeological discoveries clearly indicate a high level of metal production also in Kartli (Southern and Central Georgia), and in Western and Northern Georgia.

As it turns out, an important center of iron production in the Kartli region, in ancient times, was located in the western part of the city of Mtskheta, in the area of the city, which in the oldest Georgian historical sources was called Sarkine (in Georgian, it means - iron place). The results of archaeological excavations show that the name of this area of the old capital corresponds to the activities of its inhabitants - this is the Mtskheta enterprise, the area of iron workshops. Excavations have shown that the ironworking workshops were concentrated in a long field. The ruins of large, half-buried furnaces, in which iron was pressed, have been excavated. A large amount of iron slag found there and the ruins of furnaces provides the necessary material to confirm this judgment for us; It also turns out that the stamping of the necessary tools and tools from iron was carried out at least in two points of the "Sarkine" area: in the current "Long Field" and "Savaneti".

From what did the ancient Kartvelian (proto-Georgian) tribes produce iron, and then steel, and what ore base did the metallurgy of ancient Georgia have?

Geological factors.

It is well known that the presence of an ore base, the quality and reserves of ores predetermine both the very possibility of the emergence of metal production and the volume of gross marketable output.

Single finds of metal items in southern Georgia were noted already in the early agricultural settlements of the 6th-4th millennium BC (Khramis Didi-Gora and Arukhlo). According to I.A. Gzelishvili, the oldest metallurgical center on the territory of Georgia was the current Bolnisi region, rich in early agricultural settlements. This is confirmed by the ancient sites of copper ore mining found near Tsitelsopeli vill., as well as by a network of archaic mine workings (Th. Stöllner, Ir. Gambashidze. 2014). The only relatively large one known in Southern Georgia is the Chatakhi iron ore deposit. Of course, this deposit has been an object of industrial exploitation since time immemorial. According to prof. K.E. Gabunia, on an area mapped by him in 1933 of 70 square km. , about 30 separate areas of ore outcrops were registered and, in the same place, almost every one of them had traces of ancient mining and iron smelting. All researchers confirm that in the southern districts and regions of Georgia, many old collapsed underground mine workings are scattered, around which a huge amount of slag is observed. In Southern Georgia, the area of the Chatakhi deposit can be singled out separately. But the presence of only one Chatakhi iron ore deposit was obviously a necessary, but not a sufficient condition for creating the popularity that the ancient Georgian tribes enjoyed not only as producers, but also as pioneers of iron production.

Really, the metal-bearing zone of the Lesser Caucasus, and especially its eastern part, is covered with a network of ore, including iron ore deposits. As a result of the geological study of this ore area, its metallogenic features have been fairly clearly established. These features lie in the fact that, firstly, both hematite (Chatakhi, Madnis-tskaro, etc.) and manganese-hematite deposits (Tetritskaro, Madnis-Seri, Soshebi, Samshvilde, etc.) are concentrated within this region. Secondly, there is also a rather dense network of alluvial gold manifestations; thirdly, in this district, sulfur-pyrite, copper and polymetallic deposits of the region contain a considerable amount of silver.

In the Western part of the Lesser Caucasus, near the Black Sea coast, the great interest of ancient metallurgists were be the magnetic sands of the Chorokhi River basin and the Black Sea magnetic sands. It was the most accessible raw materials for "metallurgist", and which literally and figuratively lay on the surface. These sands of the Black Sea cost were mined in the regions of Western Georgia - in Adjara and Guria, as well as the in the ancient Georgian adjacent regions (it was part of Colchis) to this territory - Lazeti, and Tao-Klarjeti (This territories in the 20s of the 20th century were donated by Russia to Turkey). Just these sands were developed by ancient settlers. Black Sea magnetic sands are a product of the destruction of basalt rocks, which contain about 11% magnetic iron ore (Kuparadze et.all., 2018). They were carried out by numerous rivers and deposited along the river basins and the shores of the Black Sea. Obviously, these are the sands from which the famous Khalib iron was smelted in antiquity.

According to our research, these sands contain such small chemical elements as titanium, vanadium, molybdenum and chromium. It is obvious that these elements were added to iron and gave special properties (strength, whiteness and stainless properties of metal) to products made by Khalibs and Tubals.

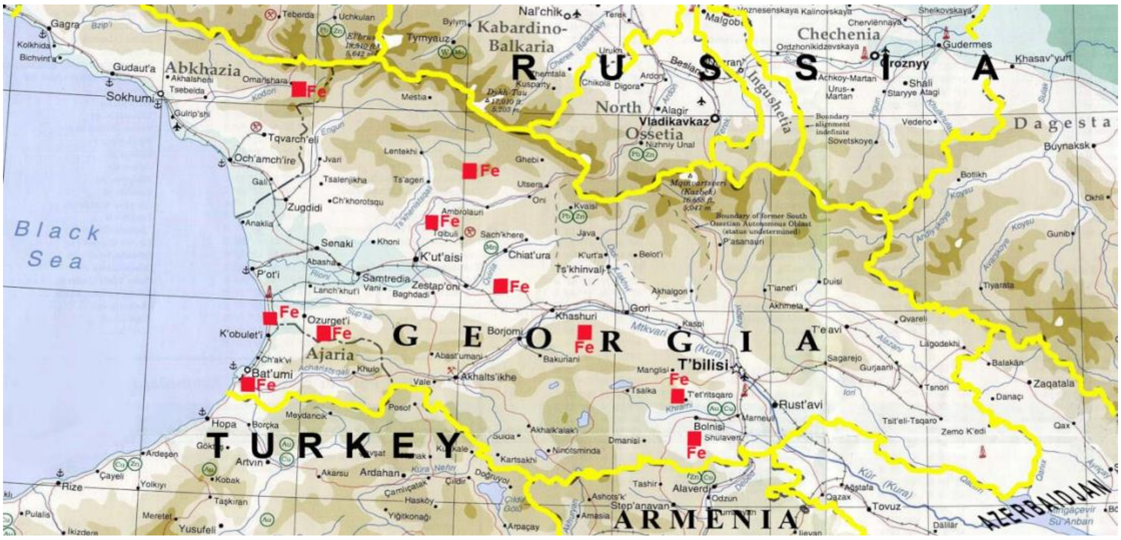

Fig.5. The main territories of modern Georgia, where iron was mined.

The role of the raw material base was played by all regions of modern Georgia, as well as part of Alaverdi. In particular, it should be noted such regions as: Bolnisi, Marneuli and Tetritskaro areas; Racha, Imereti, Samegrelo, Adjara and Abkhazia; as well as the central Georgian region - the Trialeti folded zone near the village of Dzama and, of course, the Colchis lowland (Fig. 5; 6a; 6b).

Fig. 6 a. Spearheads. Western Georgia. Iron. Turn of IX-VIII centuries BC. Funds of Kutaisi Historical Museum.
Photo by D. Kuparadze.

Fig. 6 b. Arrowhead. Discoverer of finds Kuftin. Western Georgia. Banoja village, Natsikhvara. Iron. The end of II and the beginning of I thousand years Before B.C. Funds of Kutaisi Historical museum.
Photo by D. Kuparadze.

According to the geological classification, these zones can be defined as: the Southern Slope of the Greater Caucasus Ridge, the Lesser Caucasus, including the Adjara-Trialeti folded zone located between these structures and the Colchis lowland.

More specifically, hematite (Fig.7.) and manganese-hematite (Fig.8.) deposits of Georgia are concentrated in the modern metal-bearing zone of the Lesser Caucasus.

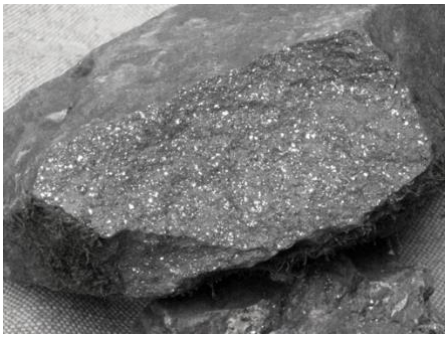

Fig. 7. Hematite ore. Southeast Georgia. Bolnisi Region. Photo by D. Kuparadze. (D.Kuparadze, D.Pataridze, 2013).

Fig. 8. Southeast Georgia. Samshvilde village. A -is a red hematite ores; B - is a dark manganese-hematite ores. Photo by D.Kuparadze. (D.Kuparadze, D.Pataridze , 2013).

In the Greater Caucasus (within Georgia) there are small deposits of magnetite in Svanetia, Abkhazia (O. Bgazba et al., 1989), Samegrelo, Racha and Imereti (regions of Georgia), as well as in the Adjaro-Trialeti zone (Dzam skarn deposit. [M.Kuparadze, 1966]) near which, on each of them, ancient metallurgical workshops were also found. It should be noted that a large number of such structures or their remains were also found on the territory of the Colchis Lowland (B.Gilmour et al. 2014). It should also be noted that similar mineralization's with a low iron content (up to 20 percent), which were obviously used for iron smelting, are presented in many regions of Georgia (D. Kuparadze, D. Pataridze. 2008), (see Fig. 9 .a, b, c). Such small mineralization near Tkibuli and Kutaisi (Fig. 9 a, c) and the iron forging workshops located near them worked quite successfully until the second half of the 20th century. On the north of Georgia, at the junction of the territories of Svaneti, Abkhazia and Mountainous Mengrelia, small deposits of magnetite with a rather high iron content (from 91 to 94%), in ancient times, artisans successfully exploited these deposits. In the Racha region, adjacent to these regions, from time immemorial ancient and up to the 19th century inclusive, blacksmithing and steelmaking were widespread. This area, in turn, had its own deposit near the village of Tsedisi, and weapons and agricultural implements made there were been exported and sold to the north, on the territory of today's Russia.

Metalworking and traditions of ancient Georgian masters of steel processing.

The ancient centers of metal production were located mainly in the South-Western, South-Eastern and Northern parts of Georgia. The first of them occupied the basin of the Chorokhi River (within the

boundaries of ancient Shavsheti, Javakheti and Tao-Klarjeti) and the territory of present-day Guria. The second covered the southern regions of ancient Iberia, where, from a metallurgical point of view, the territory of the present-day Bolnisi and Alaverdi regions was of particular interest. The northern center - occupied the mountainous regions of the Greater Caucasus within the borders of Abkhazia, Svaneti, Imereti and Racha.

Fig.9, a. Western Georgia. Imereti region. Near the town of Tkibuli. Layers of ocher. Photo by D. Kuparadze.

Fig. 9, b. Central Georgia. Kaspi district. Iron-bearing layers near the village of Metekhi. Photo by D. Kuparadze.

Fig.9, c. Kutaisi district. Shroma village. Layers of ocher. Photo by D. Kuparadze.

Literature reports on hundreds of smelting furnaces in Georgia and especially in its southwestern part, some of which have been excavated and studied (Gzelishvili, 1964; Khakhutaishvili, 2008, 2009;). Most of the material and its radiocarbon dating, as well as paleomagnetic dating for these sites, fall between the time intervals of 1500-600 BC. Limited ceramic evidence also suggests that most of the sites date back to the Late Bronze Age and Early Iron Age.

Ancient iron-smelting workshops usually consisted of a shed mounted on piles, iron-smelting raw-blowing furnaces, a stone table, and a platform for storing refractory clay. The oldest furnaces on the territory of Colchis were a pit in which ore and charcoal were laid. A dome with a short pipe was built over the pit, and fur for blowing was fitted on the side. The bottom of the pit was hemispherical,

and the walls were lined with stone (Fig. 10 a, b.). However, within these territories, the sites of metallurgical production were quite dispersed.

For many centuries, the ore from which iron was to be obtained was mined from iron ore in a cold way, it was reduced with charcoal in a furnace set in a pit into which air was blown by a blower; The reduced product (gunda) was separated from the slag and various products were made from it.
So, in Georgia there were raw materials for metal production, forests for charcoal, water for cooling and hardening products, and, finally, there were workshops, and, most importantly, experience and knowledge acquired over the centuries. Iron produced on the territory of present-day Georgia was in great demand, and products from it were distributed throughout Asia Minor - Mesopotamia, Syria, the states of Asia Minor and also in the territories north of the Main Caucasian Range. Despite the innovations associated with the technology of iron processing, the ancient metallurgists stubbornly tried to repeat the forms characteristic of bronze products, which is confirmed by the abundant archaeological material from Samtavro, Gebi, Vani, Ureki, Larilari, Chitakhevi and others

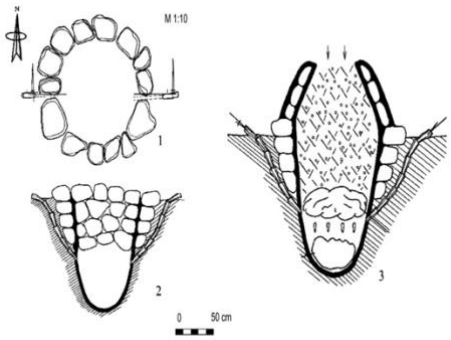

Fig. 10, a. Metallurgical center located on the territory of ancient Georgia - Amiranis Gora (G.Inanishvili. 2007; G. Kavtaradze, 1995; L.Koriakova, S.Kuzminykh, 2021).

Fig.10, b. The ovens look like holes dug in the natural clay substrate, usually just over 1 meter deep (Khakhutaishvili, 2009; Nathaniel L.Erb-Sftullo et.al., 2014).

Of course, the extraction and processing of metal mainly took place in the places where the ore was mined, but it seems that metal objects of a certain quality were processed not only in the places where this ore was mined. For example, archaeological data are also available on the smelting of high-quality iron in the town of Sarkine, (central Georgia, the area of the ancient Georgian city of Mtskheta). Production was located at this place, metal and products from it were sold and, probably, even exported from here. However, it is still unclear to us where the ancient artisans took the ore, since there are no iron ore occurrences in this area. Most likely there were places where metal was smelted in the area of the deposit, and finished iron ingots (in the form of a semi-finished product) were transported to the right places in more remote regions of Georgia. This is evidenced by the material we recently received

from the funds of the Kutaisi Museum (Fig. 11), although, it must be said, special studies on this topic have not yet been conducted (Kuparadze et al. 2017).

Fig.11. Iron blanks intended for transportation to other regions. Sachkhere district, Chala village. 1st millennium BC.
Photo by D. Kuparadze. (Kuparadze et al. 2017).

From a regional point of view, metallurgical activity throughout Georgia seems to have been concentrated in a few production areas, probably due to the location of the necessary resources: ore, fuel, water and clay. Analyzed data by previous researchers (Nathaniel L. Erb-Satullo et. Al. 2014) slag samples from different sites in the mountainous region of Adjara, undoubtedly, represent iron smelting slags. They are characterized by the presence of a large amount of metallic iron and wustite in combination with a complete absence of copper content (Fig. 12).

Fig.12. Metalworking waste found in smelting furnaces, which remain after smelting ore and ceramic tubes for blowing oxygen into the furnace and maintaining a high temperature. Batumi Museum.
Photo by D. Kuparadze.

At the beginning of the 1st millennium BC, it was very difficult to smelt iron or cast iron from ore, and only some Caucasian tribes knew secrets how to do this metalworking. But later on, to obtain steel from this iron was virtually impossible.

Steel, in principle, can be obtained in two ways - by smelting from ore or carburizing iron and quickly cooling it. In the first millennium B.C., both of these methods were used in the Caucasus (D. Kuparadze, D. Pataridze, 2008).

Over the centuries, the production chain iron - steel - damask steel has been built. What is the difference between damask steel and ordinary steel? Damask steel is the collective name for hard and

viscous alloys of iron and carbon, i.e. high carbon steel, manufactured using a special technology. According to its chemical characteristics, damask steel is close to cast iron. But physically, it retains the ductility of low-carbon steels and, at the same time, surpasses them in hardness after hardening. The main difference between damask steel and other types of steel is a unique combination of physical, mechanical, anti-corrosion and other indicators. Investigated damask steel, tried to unravel the secret of its manufacture, Michael Faraday, too. In Indian wutz, he discovered aluminum and considered that the formations of a pattern on the surface of damask steel are associated with its presence and its mechanical properties. Being an outstanding experimenter, Faraday began to alloy various chemical elements with steel. He found that the presence of impurities of silver, platinum and chromium also contributes to the formation of patterns on steel. However, he never discovered the secret of damask steel.

But it was found that in iron, in addition to carbon (in the form of coal), it was necessary to add some other metals to give it special qualities, i.e. alloy iron.

The results of our chemical analyzes of some artifacts stored in the National Museum of Georgia showed us the presence of molybdenum in many samples of Georgian steels. As an example, we can cite the results of our research on the metal from which the knife and fibula (metal clasp) are made from the Chitakhevi burial ground (7th century BC). In both samples, in addition to iron, up to 0.05% molybdenum is contained. In the same samples, the presence of silver (up to 0.2%) was also recorded. We are not inclined to think that alloying with molybdenum was the result of special thoughts and discoveries. It's just that on the territory of Georgia there are a lot of iron deposits occurrences with an admixture of molybdenum. These are the Dzama deposit, and the Tsedisi (Racha) deposit, near which the Karobi molybdenum deposit is located, etc. However, the alloying of iron with these elements was clearly appreciated by the Georgian (Kartvelian) masters of metal fabrication.

The presence of manganese in steel is common. There are several deposits with manganese-hematite mineralization in Southern Georgia (Fig.8). So, it turned out that the ancient craftsmen could use manganese ore from these deposits and, having mixed it with iron ore located there, alloyed steel was obtained from them (D. Kuparadze, D. Pataridze. 2013). Despite the fact that on the territory of Georgia (Colchis + Iberia) artisans used manganese in bulk since ancient times, we note that iron mines containing manganese were considered as “steel mines” only in 1774 by the Swedish mineralogist Bergman (Truffaut Edmond. 2019).

The most accessible high-quality raw materials, which literally and figuratively lay on the surface, were the Black Sea magnetic sands and the sands of the Chorokhi River basin (Adjara), which were developed, by ancient settlers (most likely they belonged to the Khalib populations). The important role of the region in the development of iron metallurgy was due to favorable natural and mining and geological conditions, large reserves and the specific mineralogical composition of sands. From the four main ore-forming minerals of iron, on the territory of Colchis three was noted - hematite, magnetite and limonite. The magnetic fraction in the sand reaches 23%, the iron content is 10-15%, occasionally 20%. In addition, as a result of the destruction of basic and ultrabasic rocks, Mountain Rivers washed out all the metal trace elements from them, which later were deposited on the eastern and southeastern shores of the Black Sea. These sands themselves contained the following chemical elements: Ti, Mo, V, Cr etc. Most likely because of this, the metal smelted from this ore, the improving technology that masters of smelting always kept secret, they also added “refractory stone” to the molten mass, i.e. manganese and thereby smelted the famous Khalib iron, which (according to Aristotle) had the color of silver and was considered stainless.

Iron smelting in Upper Imereti was carried out in the vicinity of the villages of Tkibuli, Satsiri, Ochzhola and Sormoni, where to this day there are small deposits of brown iron ore and iron ocher. The extraction of ores was carried out mainly from the upper horizons of the deposits, and iron was smelted from poor ores with an iron content of no more than 17% (Fig. 9 a. c.). We have information (D. Kuparadze, D. Pataridze 2013) that in the region of Georgia - Racha, in the 18-19 centuries, the master of making iron tools and metal, into the molten mass for weapons added local bauxite ore and received a shiny and stainless inventory. The ore base was represented by deposits of iron sheen, red iron ore and limonite, which were deposited in irregular nests of various sizes.

We had the opportunity to study the metal from which the Georgian sword was made in the X-XI centuries AD. It is stored in the storerooms of the National Museum of Georgia. In addition to iron, the fragment of the handle contains about 1% zinc. This means that either Madneuli (Kvemo Kartli region) or Kvaisa (Shida Kartli region) ore could be used to smelt this product.

It is unlikely that the ancient Georgian master metallurgists of that time had a huge baggage of "scientific" knowledge, which made it possible to obtain high-alloy steel grades. Most likely they dealt with very pure and rich oxide ores, alloyed them with other ores and reduced them at temperatures below the melting point of iron (1539 C). Melting was carried out in small furnaces and crucibles and not very hot metal was slowly forged. The technique and technology of the smelter and blacksmith gradually improved, which subsequently gave very positive results.

As we already wrote, the most final and required highest quality technology during the melting of iron is the production of the so-called "Damascus steel" made of steel.

The main purpose of damask steel is the manufacture of blades with a spicy blade, and the sharpness remains for a very long time, while for blades made of ordinary carbon steel, the sharpened blade decreases already during sharpening. Damascus steel simultaneously has high hardness, toughness and elasticity, which contributes to the self-sharpening of the blade. Therefore, Georgian damask blades freely cut iron nails and at the same time freely bent into an arc and even were worn instead of a belt. If necessary, the curved blade was immediately taken out of its sheath and used as a melee weapon (Fig. 13). A good blade easily cut a gauze handkerchief in the air, while even modern blades made of the best steel can cut only dense types of silk fabrics.

Fig.*13. Georgian dagger. Damask steel. If necessary, the dagger*
Had the opportunity to replace the belt on the body, and when it was taken out of the scabbard, it instantly straightened out like a spring and took on its natural shape.
The technology was restored by a modern Georgian master – Gocha Lagidze.

Despite the fact that the best damask blades were forged in the 7th-12th centuries, in their immortal works -Firdousi, Nizami, Rustaveli and others (XII-XIII centuries) often described the weapons of their heroes, but never mentioned their origin. In the manuscripts of that time, only the rites that preceded the work of the masters were described. The well-known weapons historian V. V. Arent wrote that in ancient times the art of the gunsmith was considered the heritage of the Gods. Masters prepared for work as for a feat. And only people who are pure in soul and body could create an ideal blade. Prayer, absolute abstinence from strong drinks, meat and fish, distance from women who were forbidden to cross the threshold of the forge, repeated ablutions - this is not a complete list of rules that the gunsmith had to follow. The master worked in full dress. Above the anvil were fixed images of deities blessing the place of high service. Work on the blade lasted for months, and often for years.

Recipes for making damask steel have been kept in the deepest secret for centuries. If the master did not have offspring in the male line or the son did not inherit the skills of his father, then there was

simply no one to pass on his experience to. This led to the fact that, unfortunately, the process of succession of generations of craftsmen was disrupted and, as a result, the technology for obtaining high-quality damask steel and making products from it was lost by the 14th century.

Daggers and swords from Damascus steel, like a shrine, were passed down from generation to generation and preserved with such zeal that the warriors, first of all, took care of saving their weapons. Damascus steel have preserved and still preserve constant value in all regions of Asia - in India, in Japan, in China, in Persia, in Turkey and in Georgia.

The production of damask steel in Georgia, in our opinion, after a long lull, resumed in the 18th century. Melee weapons were produced mainly in the mountainous regions of Georgia, but only a few cities knew how to make welding damask. Tiflis-made weapons were famous far beyond the Caucasus. There is evidence that in the 18th century swords and daggers were supplied to the mountain peoples of the Caucasus and Iran from Tiflis. In the 19th century Tiflis continued to be a center for the manufacture of weapons from welding damask.

Georgian welding damask was widely known. Many noted its correspondence with the best samples of Indian and Damascus «damask steel» (Fig. 14). According to available information [Gurevich Yu.G., 1985, Arkhangelsky L.B.] in 1827, an official of the workshop of the Armory Chamber of the Russian Empire, a certain Georgian nobleman G.I. Revaz (most likely, instead of the name of a nobleman, the name is indicated) for the first time made at the Tula (Russia) arms factory several samples of damask steel and saber blades from it. The blades emitted a sharp and high-pitched ringing, and the pattern was preserved even after the samples were melted down. Revaz offered to reveal the secret of smelting damask steel and made it possible to transfer experience to Russian masters. However, the recipe he described for making damask steel from iron, cast iron and ore aroused distrust among local metallurgists, who believed that this method "contradicts the sound concepts of the original rules of chemistry."

For decades, the Georgian Eliazarashvili family has been famous for its damask steel. Based on the results of his research, the well-known Georgian historian, a specialist in the field of steel production in Georgia, K. Cholokashvili, established that “this family inherited the secret of making damask steel from their ancestors.” Especially popular was the weapon made by the master of damask weapons Georgy Eliazaroshvili (later, the Russian imperial chauvinists his surname was renamed as Eliazarov), who made damask steel "of high dignity for swords", wrote in 1841 "Mining Journal".

Fig. 14. Typical Tiflis dagger. Damascus steel. Master Solomon Eliazarashvili. 1850 year. National Museum of Georgia. Photo by David Kuparadze.

The son of George - Karaman continued his father's work and created damask weapons from Georgian horseshoes, sawdust of Turkish steel, cast iron and strips of wrought iron. “This weapons made from Georgian damask steel were of such high quality that when testing blades, they cut off the head of a bull or a cow with one blow” (Arkhangelsky L.B.).

The penetration of damask steel to the north, to Russia, went in two ways. One path lay through Georgia, and the other led from Samarkand, since it was the Samarkand emir Tamerlane (1336-1405) who contributed to the widespread distribution of damask steel in Central Asia. After the conquest of Syria and the capture of Damascus, he took all the masters to the countries subject to him.

The process of making high-quality Damascus steel blades was very labor intensive. The complex production technology required great experience and knowledge and included a number of complex technical operations, without which it was impossible to obtain steels with the required properties. Even small deviations from technological schemes led to irreversible marriage.

According to K. Cholokashvili, gleaned from the "Acts of the Caucasian Archival Company", Karaman Eliazaroshvili in 1828 revealed a recipe for making Georgian saber steel with an artificially carburized surface. According to the archival data of 1888 obtained by the Georgian ethnographer K. Cholokashvili, "the best blades in the Russian cavalry were those made by Eliazaroshvili's students." The sabers made by Eliazarashvili were donated to Emperor Nicholai I already in 1832 and are now kept in the Hermitage and in the Moscow Historical Museum.

By the end of the 19th century, with the improvement of firearms, cold steel weapons from welding damask steel were practically not produced anywhere. And what was used was made from steels that were easier to manufacture and cheaper. For example, in such traditionally "damask" countries as India and Syria, cold steel weapons were forged from ordinary grades of English or Swedish steel.

In the USSR, the lost secrets of obtaining welding damask became known thanks to the work of K. Cholokashvili. The recipe he found for making Georgian damask steel was transferred to the Institute of Metallurgy of the Academy of Sciences of the Georgian SSR, where it was carefully studied. As a result, in one of the workshops of the Rustavi Metallurgical Plant, under the guidance of Academician of the Academy of Sciences of the Georgian SSR F. Tavadze, experimental samples of welding damask steel were obtained, quite accurately repeating the patterns and properties of museum exhibits (Amaglobeli B.G., 2007).

It should be noted that in the process of studying damask steels, the main secret may not have been revealed, but the mystery and almost mystical admiration for the miracle metal has led to many amazing discoveries in modern metallurgy (Fig. 15.a.b.).

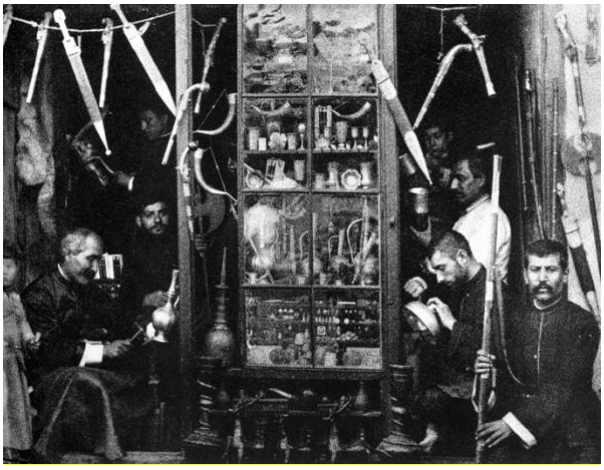

Fig.15.a. Shop-workshop of gunsmiths of the late 19th century. Tiflis. Photo from the early 1890s. National Museum of Georgia.

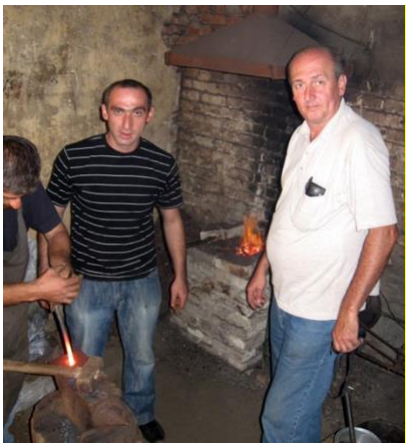

Fig.15.b. The modern master of manufacturing high-quality metal, steel, damask steel and cold weapons from the city of Gori is Zakhary (Zakro) Nonikashvili (in the center).

The use of modern research methods, the latest and most advanced equipment, a great desire to recreate the lost and unlimited industriousness are the guarantors of the successful solution of the tasks set by modern Georgian masters of their craft. After all, the role of the master, his skills and intuition are priceless.

Fortunately, from the end of the previous century to the present day, a whole generation of great masters of metal and edged weapons has grown up in Georgia (as an example, you can see this at least on the website http://www.georgians-weapons.com/uk-galery. htm). You just have to be surprised at their desire to recreate all the technique and technology of the ancestors of the Georgians, who left an outstanding contribution to the extraction of material, their alloying, smelting metal and steel and later damask steel. Fortunately, they were able to achieve a very high level of metal production and the creation of edged weapons, and based on this, some of them were invited to Europe for permanent work to create new masterpieces and restore old weapons artifacts (Fig. 16).

Fig.16. Exact copies of damask swords of the Georgian master of metalworking of the 19th century - George Eliazaroshvili. The work was done by modern Georgian masters Gocha Lagidze and Zakhary (Zakro) Nonikashvili.

The dagger, with the discovery of which our research began, presumably turned out to be the work of one of the masters of the Eliazaroshvili family and was made in the 19th century. According to

a private assessment of a well-known specialist in the history of edged weapons, vice-president of the Union of Russian Blacksmiths Leonid Arkhangelsky, the dagger was made by a master of the highest level, and the type of pattern on the metal is called "warm-fa" - a bright worm / snake, about which was first mentioned in the Anglo-Saxon epic poem Beowulf, created at the beginning of the 8th century.

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